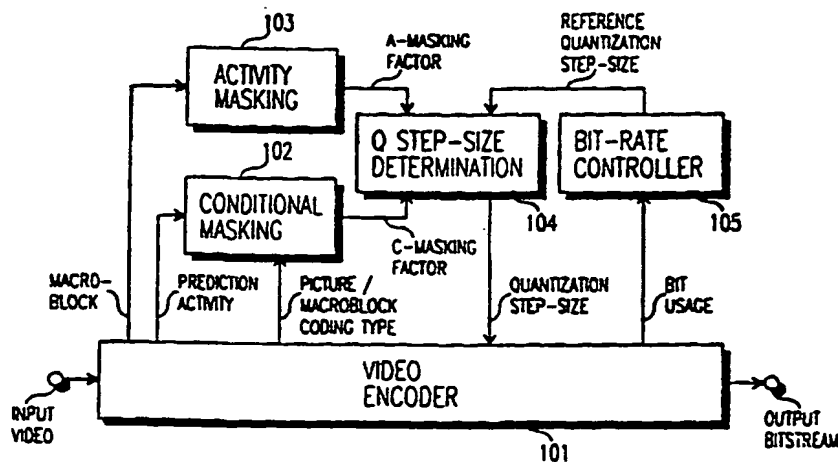




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification <sup>6</sup> :</b> <b>H04N 7/50</b>	<b>A1</b>	<b>(11) International Publication Number:</b> <b>WO 99/59344</b> <b>(43) International Publication Date:</b> 18 November 1999 (18.11.99)
<b>(21) International Application Number:</b> PCT/SG98/00034 <b>(22) International Filing Date:</b> 12 May 1998 (12.05.98)  <b>(71) Applicant (for all designated States except US):</b> SGS-THOMSON MICROELECTRONICS ASIA PACIFIC (PTE) LTD. [SG/SG]; 28 Ang Mo Kio Industrial Park 2, Singapore 569508 (SG).  <b>(72) Inventor; and</b> <b>(75) Inventor/Applicant (for US only):</b> HUI, Yau, Wai, Lucas [SG/SG]; 10H Braddell Hill #24-31, Singapore 579727 (SG).  <b>(74) Agent:</b> DONALDSON & BURKINSHAW; P.O. Box 3667, Singapore 905667 (SG).		<b>(81) Designated States:</b> JP, SG, US, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).  <b>Published</b> With international search report.

(54) Title: CONDITIONAL MASKING FOR VIDEO ENCODER



## (57) Abstract

This method and apparatus described herein imposes masking factors to the determined quantization step sizes of macroblocks of a video sequence such that encoding efficiency is increased. A conditional masking method can be used to take advantage of the fact that P-pictures are more important than B-pictures in terms of motion and scene updates as coding noise in such updates are likely propagated by P-pictures. The masking can be applied conditionally to motion/scene update regions of a picture such that coding noise is reduced and therefore bits are saved from less propagation of this noise. Before encoding each macroblock of a picture from an input video sequence, a video encoder with conditional masking determines if the macroblock type belongs to a significant motion or scene update region. A conditional masking factor is then determined for the macroblock based on the determined macroblock type and the picture coding type. The conditional masking factor is combined with a macroblock reference quantization step-size which may be calculated using conventional methods based on bit allocation and bit utilization, and an optional activity masking factor based on activity level of the macroblock and/or its surrounding region to form the final quantization step-size for coding of the macroblock.

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

- 1 -

## CONDITIONAL MASKING FOR VIDEO ENCODER

### Technical Field

5 The present invention relates to a method and apparatus for encoding video sequences. In particular, the present invention relates to a method and apparatus for quantization step size determination for compression of video signals.

### Background Art

10

Methods for encoding moving pictures or video had been developed for efficient transmission and storage. A current art of such encoding methods is found in MPEG2 Test Model 5, ISO/IEC JTC1/SC29/WG11/NO400, April 1993, and the disclosure of that document is hereby expressly incorporated herein by reference. In this method, an input video sequence is organized  
15 into sequence layer, group-of-pictures, pictures, slices, macroblocks, and finally block layer. Each picture in a group-of-pictures will be coded according to its determined picture coding type.

The picture coding types used in the MPEG2 Test Model 5 include intra-coded picture (I-picture), predictive-coded picture (P-picture), and bi-directionally predictive-coded picture (B-picture). The I-pictures are used mainly for random access or scene update. The P-pictures use forward motion predictive coding with reference to previously coded I- or P-pictures (anchor pictures), and the B-pictures use both forward and backward motion predictive/interpolative coding with reference to previously coded I- or P-pictures. A group of pictures (GOP) is formed  
25 in encoded order starting with an I-picture and ending with the picture before the next I-picture in the sequence.

A picture is partitioned into smaller and non-overlapping blocks of pixel data called macroblocks (MB) before encoding. Each MB from a P- or B-picture is subjected to a motion estimation  
30 process in which forward motion vectors, and backward motion vectors for the case of a B-picture MB, are determined using reference pictures from a frame buffer. With the determined

- 2 -

motion vectors, motion compensation is performed where in the intra- or inter-picture prediction mode of the MB is first determined according to the accuracy of the motion vectors found, followed by generating the necessary predicted MB.

- 5 The predicted MB is then subjected to discrete cosine transform (DCT) and quantization of the DCT coefficients based on quantization matrices and quantization step-size. The quantized DCT coefficients of the MB is then run-length encoded with variable length codes (VLC) and multiplexed with additional information such as selected motion vectors, MB coding modes, quantization step-size, and/or picture and sequence information, to form the output bitstream.

10

Local decoding is performed by inverse quantizing the quantized DCT coefficients, followed by inverse DCT, and motion compensation. Local decoding is performed such that the reference pictures used in the motion compensation are identical to those used by any external decoder.

- 15 The quantization step-size (QS) used for quantizing the DCT coefficients of each MB has direct impact on the number of bits produced at the output of run-length VLC encoding process, and therefore the average output bit rate. It has also a direct impact on the encoding quality, which represents the output picture quality at the corresponding decoder. In general, larger QS generates lower output bit rate and lower encoding quality. In order to control output bit rate  
20 and picture quality so that the resulting bitstream can satisfy channel bandwidth or storage limitation as well as quality requirements, rate control and quantization control algorithms are used.

- Some methods for rate control and quantization control can be found in the above mentioned  
25 MPEG-2 Test Model 5. These methods comprise generally a bit allocation process, a rate control process, and an adaptive quantization process. In the bit allocation process, a target number of bits is assigned for a new picture to be coded according to a number of previously determined and pre-set parameters. The rate control step then calculates a reference quantization step-size for each MB based on the target bits for the picture and the number of bits already used  
30 from the target bits in encoding MBs from that picture. In the adaptive quantization process, the calculated reference quantization step-size is scaled according to local activities of the MB, and

- 3 -

an average MB activity determined from the current or a previously coded picture. This scaling is done according to a level of masking effects of coding noise by human perception for MB with high or low activities within a picture. A video buffer verifier (VBV) may also be employed in such a way that underflow and overflow of the decoder input buffer are prevented as required  
5 by the MPEG standard to ensure a target bit rate is maintained.

Coding efficiency, which can be measured in terms of bit-rate saving or encoding picture quality improvement, is a key design issue for video encoder systems. An improvement in coding efficiency will have a large impact in communication or storage costs saving in a long run.

10

While various methods for enhancing coding efficiency may be developed, it is necessary to consider their impacts on implementation cost in particular when the systems are to be broadly used. Furthermore, it is desired that such methods for encoding should not introduce incompatibility problems inter-operating with decoders that are known to date (for example the  
15 MPEG video decoders).

### Summary of the Invention

It is therefore an object of the present invention to provide a method or apparatus for use in a  
20 video encoder to enhance its coding efficiency.

In accordance with the present invention, there is provided a video encoder for encoding sequences of images comprising intra-coding pictures and predictive-coding pictures into an encoded output bitstream, including:

25 an encoding processor for encoding each image of a sequence by partitioning the image into a plurality of macroblocks, performing necessary motion compensation and estimation and an orthogonal transform on each macroblock, and quantizing the transform coefficients according to a quantization step-size for incorporation in the output bitstream;

a conditional masking processor which is adapted to process macroblocks of predictive-  
30 coding pictures to determine if each macroblock belongs to a significant motion or scene update region of the corresponding image, and determine a conditional masking factor based on the

- 4 -

determination; and

a quantization step-size processor coupled to receive the conditional masking factor from the conditional masking processor and generate a quantization step-size value, based on a reference quantization step-size and the conditional masking factor, for use by the encoding  
5 processor in encoding each macroblock.

The present invention also provides a method for use in video encoding for encoding sequences of images comprising intra-coding pictures and predictive-coding pictures into an encoded output bitstream, including the steps of:

- 10 partitioning images into a plurality of macroblocks;  
processing macroblocks of predictive-coding pictures to determine if each macroblock belongs to a significant motion or scene update region of the corresponding image and determining a corresponding conditional masking factor;  
generating a quantization step-size value based on a reference quantization step-size and  
15 the conditional masking factor; and  
encoding each image by performing necessary motion compensation and estimation and an orthogonal transform on each macroblock, and quantizing the transform coefficients according to the generated quantization step-size, for incorporation in the output bitstream.

- 20 Embodiments of the present invention make use of a conditional masking method to take advantage of the fact that P-pictures are more important than B-pictures in terms of motion and scene updates as coding noise in such updates are likely propagated by P-pictures.

- The masking can be applied conditionally to motion/scene update regions of a picture such that  
25 coding noise is reduced and therefore bits are saved from less propagation of this noise. The conditional masking method can also make use of the fact that these updates attract visual attention and should be coded with less distortions.

- Before encoding each macroblock of a picture from an input video sequence, a video encoder  
30 with conditional masking according to an embodiment of the present invention determines if the macroblock type belongs to a significant motion or scene update region. A conditional masking

- 5 -

factor is then determined for the macroblock based on the determined macroblock type and the picture coding type.

The conditional masking factor is combined with a macroblock reference quantization step-size  
5 which may be calculated using conventional methods based on bit allocation and bit utilization, and an optional activity masking factor based on activity level of the macroblock and/or its surrounding region to form the final quantization step-size for coding of the macroblock.

The video encoder may utilize motion estimation, motion compensation, discrete cosine  
10 transform coding, and run-length encoding with variable length codes as video compression techniques.

#### Brief Description of the Drawings

15 The invention is described in greater detail hereinbelow, by way of example only, with reference to a preferred embodiment thereof and the accompanying drawings, wherein:

Figure 1 is a block diagram illustrating a video encoder with conditional masking according to an embodiment of the present invention; and

Figure 2 is a block diagram illustrating a conditional masking factor calculation unit  
20 according to one embodiment of the invention.

#### Detailed Description of the Preferred Embodiments

Figure 1 illustrates an embodiment of a video encoder with conditional masking according to the  
25 present invention. An input video sequence is encoded by video encoder 101 to produce a compressed output bitstream which may be transmitted to an external decoder via a communication channel or recorded on digital storage media for playback applications. Typically, the video encoder 101 utilizes motion estimation, motion compensation, discrete cosine transform coding, and run-length encoding with variable length codes as video  
30 compression techniques. A video encoder may be implemented such that the output bitstream is compliant to one of the ISO/IEC MPEG standards, and can be decoded by the corresponding

- 6 -

MPEG video decoders.

A rate controller 105 calculates a reference quantization step-size for each macroblock in a picture from the input video based on a predetermined target output bit-rate, and bit usage by  
5 the video encoder 101. The reference quantization step-size defines the level of quantization to be applied within the video encoder 101 such that the output number of bits generated for coding the macroblocks can be controlled. The controlling of bits in turn maintains the target output bit-rate and prevents overflow and/or underflow of a corresponding decoder input buffer.

- 10 An embodiment of the rate controller 105 may be found in the MPEG-2 Test Model 5. A target number of bits for coding a picture is first determined based on target output bit-rate, picture coding type, bit usage and average quantization step-sizes of past coded pictures. With the determined target number of bits, the reference quantization step-size is calculated for each macroblock of the picture. VBV checking and correction may also be applied in the rate  
15 controller.

In certain applications, the rate controller 105 may produce fixed reference quantization step-sizes. Such methods may be useful for constant quality or variable bit-rate encoding.

- 20 With each macroblock, an activity masking module 103 determines an A-masking factor. The A-masking factor is an activity scaling factor for the determined reference quantization step-size to enhance encoding quality based on human perception. It is determined by the local and/or surrounding activities of the macroblock and an average activity from the current or a previously coded picture. An example embodiment of activity masking is described in the MPEG-2 Test  
25 Model 5 Adaptive Quantization method.

- Conditional masking 102 is also applied to each macroblock. In a particular embodiment, a C-masking factor is determined for each macroblock which is not intra-coded, and dependent on the picture coding type (P-picture or B-picture). The C-masking factor is determined such that  
30 higher masking is generated for macroblocks not belonging to a significant motion or scene update region. Furthermore, additional masking is given for such macroblocks belonging to a



- 7 -

B-picture. Prediction activity in the form of macroblock prediction error variance may be used to determine if the macroblock belongs to a significant motion or scene update region. Such prediction error variance is usually obtained from the motion vector decision (motion compensation) process. It is given by:

$$P_{act} = \frac{1}{m} \sum_{i=1}^m [MB_{original}(i) - MB_{predicted}(i)]^{\alpha}$$

where  $MB_{original}(i)$  is the  $i^{th}$  pixel of the macroblock to be coded,  
 $MB_{predicted}(i)$  is the  $i^{th}$  pixel of a predicted macroblock,  
 $m$  is the total number of pixels in a macroblock,  
 $P_{act}$  is the prediction activity, and  
 $\alpha$  is a constant (e.g. 1 or 2).

A Q Step-Size Determination module 104 applies the determined A-masking factor and C-masking factor to the reference quantization step-size to produce the final quantization step-size. The quantization step-size is to be used by the video encoder 101 to quantize the macroblock. Motion compensation and discrete cosine transform may be performed for the macroblock before it is quantized. The quantized macroblock is run-length encoded with variable length codes, multiplexed together with all necessary side information to form the output bitstream. An equation for determining the quantization step-size is given by:

$$Q_s = Q_{ref} \times A_{masking} \times C_{masking}$$

where  $Q_s$  is the quantization step-size,  
 $Q_{ref}$  is the reference quantisation step-size,  
 $A_{masking}$  is the determined A-masking factor, and  
 $C_{masking}$  is the determined C-masking factor.

An embodiment of the Conditional masking factor calculation unit is illustrated in block diagram form in Figure 2. An average of the prediction activity is calculated by frame average 201 for a coded picture and the result is stored in memory 202. Two average prediction activities will

SUBSTITUTE SHEET (RULE 26)

- 8 -

be determined, one for a past coded P-picture and one for a past coded B-picture. The averaging process takes into account only macroblocks which are not intra-coded and indicated by the macroblock coding type.

A condition comparator 203 is used to compare the prediction activity of the current macroblock and the average prediction activity of a past coded picture of the same picture coding type to decide whether or not the macroblock type belongs to a significant motion or scene update region. It is not necessary to compare intra-coded macroblocks (e.g. macroblocks from I-pictures) as they are naturally considered as scene update regions.

With the decided macroblock type, a masking generator 204 determines the conditional masking (C-masking) factor. As mentioned earlier, the C-masking factor is determined such that higher masking is generated for macroblocks not belonging to a significant motion or scene update region; and furthermore, additional masking is given for such macroblocks belonging to a B-picture.

A simplified implementation of the condition comparator 203 and masking generator 204 is represented by the following pseudo code:

```

If (picture_coding_type == P-picture) {
    If ( $P_{act} < P_{average}$ ) C-Masking =  $K_1$  ;
    else C-Masking =  $K_2$  ;
}

If (picture_coding_type == B-picture) {
    If ( $P_{act} < B_{average}$ ) C-Masking =  $K_3$  ;
    else C-Masking =  $K_4$  ;
}

```

where  $P_{act}$  is the prediction activity of the current macroblock,  
 $P_{average}$  is the average  $P_{act}$  of a previously coded P-picture,  
 $B_{average}$  is the average  $P_{act}$  of a previously coded B-picture, and

SUBSTITUTE SHEET (RULE 26)

- 9 -

$K_1$ ,  $K_2$ ,  $K_3$  and  $K_4$  are constants (e.g  $K_1 > K_2$ ,  $K_3 > K_4$ )

Conditional masking is incorporated into a video encoder such that when encoding a video sequence using constant bit-rate the overall encoding quality will be improved. In variable bit-rate operation where constant encoding quality is maintained, a video encoder with conditional masking according to the present invention will reduce the actual bit-rate required for encoding. In particular, a lesser number of bits will be required for encoding B-pictures in a sequence with the present invention.

As will be apparent to those of ordinary skill in the art of video encoding, the present invention and video encoders incorporating the present invention can be implemented in any of a variety of ways such as embodied in a computer program operating on general purpose computing apparatus or in a custom designed integrated circuit for incorporation into other electronic apparatus, for example. The actual implementation of the methods of the present invention described hereinabove into known forms of video encoders is considered a matter of routine to those skilled in the art, and is not described further herein so as to avoid obscuring the principles of the invention.

The foregoing detailed description of the present invention has been presented by way of example only, and is not intended to be considered limiting to the invention which is defined in the claims appended hereto.

Throughout this specification and the claims which follow, unless the context requires otherwise, the word "comprise", and variations such as "comprises" and "comprising", will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

SUBSTITUTE SHEET (RULE 26)

Claims

1. A video encoder for encoding sequences of images comprising intra-coding pictures and predictive-coding pictures into an encoded output bitstream, including:
  - 5 an encoding processor for encoding each image of a sequence by partitioning the image into a plurality of macroblocks, performing necessary motion compensation and estimation and an orthogonal transform on each macroblock, and quantizing the transform coefficients according to a quantization step-size for incorporation in the output bitstream;
  - a conditional masking processor which is adapted to process macroblocks of predictive-  
10 coding pictures to determine if each macroblock belongs to a significant motion or scene update region of the corresponding image, and determine a conditional masking factor based on the determination; and
  - a quantization-step-size processor coupled to receive the conditional masking factor from the conditional masking processor and generate a quantization step-size value, based on a  
15 reference quantization step-size and the conditional masking factor, for use by the encoding processor in encoding each macroblock.
2. A video encoder as claimed in claim 1, wherein the determination of whether a  
macroblock belongs to a significant motion or scene update region of the corresponding image  
20 is based upon a comparison of a prediction activity of the macroblock and an average prediction activity for a previously coded picture.
3. A video encoder as claimed in claim 2, wherein the conditional masking processor  
includes a prediction activity averaging processor for determining an average prediction activity  
25 for a previously encoded image.
4. A video encoder as claimed in claim 3, wherein the predictive-coding pictures of the  
image sequence include mono-directional predictive coding pictures (P-pictures) and bi-  
directional predictive coding pictures (B-pictures), and wherein the prediction activity averaging  
30 processor determines an average prediction activity for each type of predictive coding picture.

- 11 -

5. A video encoder as claimed in claim 3, wherein if a measured prediction activity value for a macroblock is less than the average prediction activity then the conditional masking factor is set to a first value, otherwise the conditional masking factor is set to a second value.

6. A video encoder as claimed in claim 4, wherein for a macroblock from a P-picture, a value for the conditional masking factor is selected by said conditional masking processor from between first and second values according to a comparison between the macroblock prediction activity and the P-picture average prediction activity, and wherein for a macroblock from a B-picture, a value for the conditional masking factor is selected by said conditional masking processor from between third and fourth values according to a comparison between the macroblock prediction activity and the B-picture average prediction activity.

7. A video encoder as claimed in claim 6, wherein said first value is greater than said second value, and said first value is selected if the macroblock prediction activity is less than the P-picture average prediction activity.

8. A video encoder as claimed in claim 6 or 7, wherein said third value is greater than said fourth value, and said third value is selected if the macroblock prediction activity is less than the B-picture average prediction activity.

9. A video encoder as claimed in any one of claims 2 to 8, wherein the prediction activity for a macroblock is determined according to:

$$P_{act} = \frac{1}{m} \sum_{i=1}^m [MB_{original}(i) - MB_{predicted}(i)]^{\alpha}$$

where  $MB_{original}(i)$  is the  $i^{th}$  pixel of the macroblock to be coded,

$MB_{predicted}(i)$  is the  $i^{th}$  pixel of a predicted macroblock,

$m$  is the total number of pixels per macroblock,

$P_{act}$  is the prediction activity, and

$\alpha$  is an integer constant.

SUBSTITUTE SHEET (RULE 26)

- 12 -

10. A video encoder as claimed in any one of claims 1 to 9, further including an activity masking processor coupled to the quantization step-size processor, for generating an activity masking factor based on human perceptual limitations, and wherein the quantization step-size value generated by said quantization step-size processor is also based on the activity masking factor.

11. A video encoder as claimed in claim 10, wherein the quantization step-size value generated by the quantization step-size processor is determined according to:

$$Q_s = Q_{ref} \times A_{masking} \times C_{masking}$$

where  $Q_s$  is the quantisation step-size,

$Q_{ref}$  is the reference quantisation step-size,

$A_{masking}$  is the activity masking factor, and

$C_{masking}$  is the conditional masking factor.

12. A method for use in video encoding for encoding sequences of images comprising intra-coding pictures and predictive-coding pictures into an encoded output bitstream, including the steps of:

partitioning images into a plurality of macroblocks;

processing macroblocks of predictive-coding pictures to determine if each macroblock belongs to a significant motion or scene update region of the corresponding image and determining a corresponding conditional masking factor;

generating a quantization step-size value based on a reference quantization step-size and the conditional masking factor; and

encoding each image by performing necessary motion compensation and estimation and an orthogonal transform on each macroblock, and quantizing the transform coefficients according to the generated quantization step-size, for incorporation in the output bitstream.

13. A method as claimed in claim 12, wherein the determination of whether a macroblock

- 13 -

belongs to a significant motion or scene update region of the corresponding image is based upon a comparison of a prediction activity of the macroblock and an average prediction activity for a previously coded picture.

5 14. A method as claimed in claim 13, including maintaining a record of average prediction activities for previously encoded images.

15. A method as claimed in claim 14, wherein the predictive-coding pictures of the image sequence include mono-directional predictive coding pictures (P-pictures) and bi-directional  
10 predictive coding pictures (B-pictures), and wherein a record is maintained of the average prediction activity for each type of predictive coding picture.

16. A method as claimed in claim 14, wherein if a measured prediction activity value for a macroblock is less than the average prediction activity then the conditional masking factor is set  
15 to a first value, otherwise the conditional masking factor is set to a second value.

17. A method as claimed in claim 15, wherein for a macroblock from a P-picture, a value for the conditional masking factor is selected from between first and second values according to a comparison between the macroblock prediction activity and the P-picture average prediction  
20 activity, and wherein for a macroblock from a B-picture, a value for the conditional masking factor is selected from between third and fourth values according to a comparison between the macroblock prediction activity and the B-picture average prediction activity.

18. A method as claimed in claim 17, wherein said first value is greater than said second  
25 value, and said first value is selected if the macroblock prediction activity is less than the P-picture average prediction activity.

19. A method as claimed in claim 17 or 18, wherein said third value is greater than said fourth value, and said third value is selected if the macroblock prediction activity is less than the  
30 B-picture average prediction activity.

- 14 -

20. A method as claimed in any one of claims 13 to 19, wherein the prediction activity for a macroblock is determined according to:

$$P_{act} = \frac{1}{m} \sum_{i=1}^m [MB_{original}(i) - MB_{predicted}(i)]^\alpha$$

where  $MB_{original}(i)$  is the  $i^{th}$  pixel of the macroblock to be coded,  
 $MB_{predicted}(i)$  is the  $i^{th}$  pixel of a predicted macroblock,  
 $m$  is the total number of pixels per macroblock,  
 $P_{act}$  is the prediction activity, and  
 $\alpha$  is an integer constant.

21. A method as claimed in any one of claims 12 to 20, further including a step of generating an activity masking factor based on human perceptual limitations, wherein the generated quantization step-size value is also based on the activity masking factor.

22. A method as claimed in claim 21, wherein the quantization step-size value is generated according to:

$$Q_s = Q_{ref} \times A_{masking} \times C_{masking}$$

where  $Q_s$  is the quantisation step-size,  
 $Q_{ref}$  is the reference quantisation step-size,  
 $A_{masking}$  is the activity masking factor, and  
 $C_{masking}$  is the conditional masking factor.



1/2

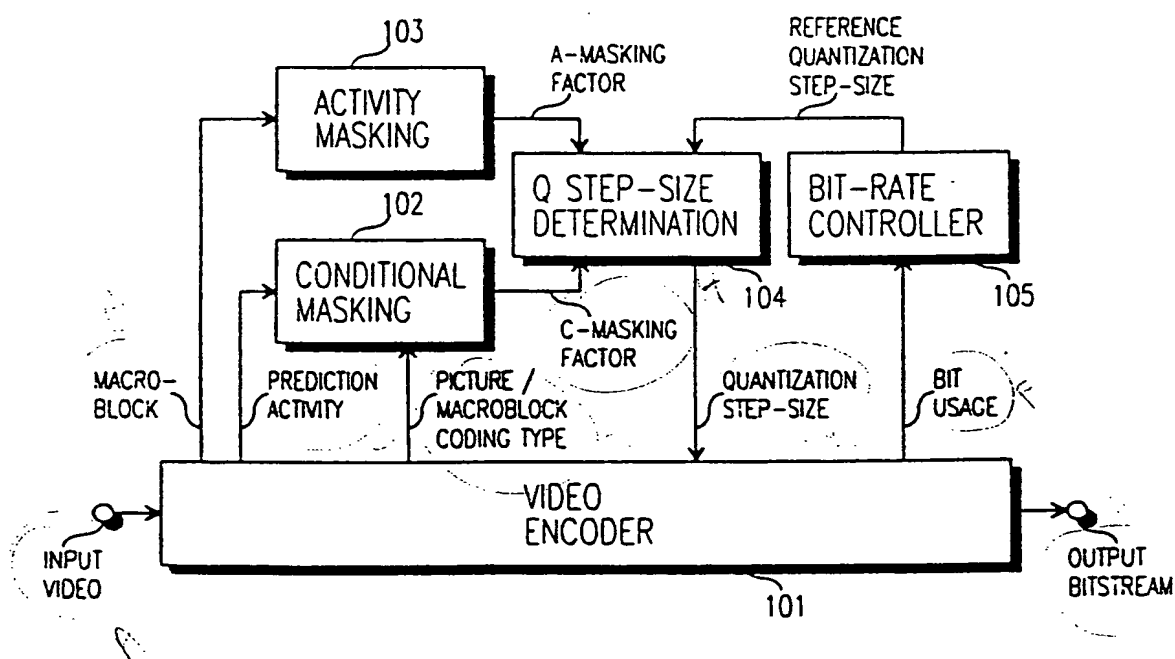
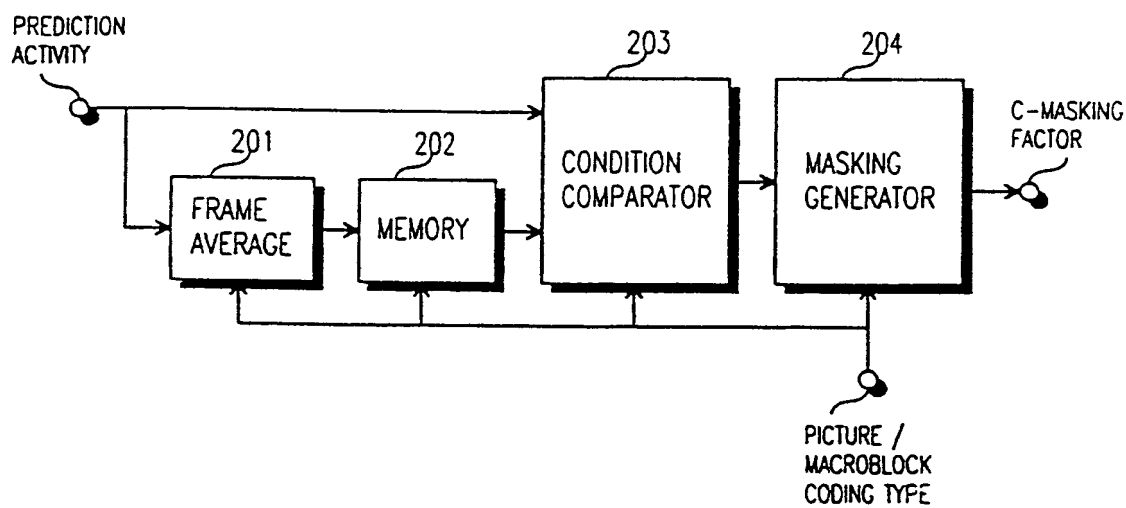


FIG. 1

FIG. 2

# INTERNATIONAL SEARCH REPORT

In tional Application No

PCT/SG 98/00034

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 6 H04N/50

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 686 963 A (WELLS AARON ET AL) 11 November 1997  see column 4, line 29 - column 5, line 52 see column 8, line 32 - column 12, line 8 see column 15, line 38 - column 15, line 54	1-5, 9, 10, 12-16, 20, 21
A		6-8, 11, 17-19, 22
X	EP 0 828 393 A (THOMSON MULTIMEDIA SA) 11 March 1998 see column 2, line 55 - column 6, line 53  -/--	1, 10-12, 21, 22

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

7 January 1999

Date of mailing of the international search report

14/01/1999

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2.30 HV Rijswijk  
Tel. (+ -70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+ -70) 340-3016

Authorized officer

Fassnacht, C

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/SG 98/00034

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PICKERING M R ET AL: "A VBR rate control algorithm for MPEG-2 video coders with perceptually adaptive quantisation and traffic shaping" SIGNAL PROCESSING. IMAGE COMMUNICATION, vol. 11, no. 1, November 1997, page 1-19 XP004097818 see page 3, left-hand column, line 15 - page 11, left-hand column, line 18 ----	1,12
X	EP 0 705 040 A (SONY CORP) 3 April 1996 see page 7, line 31 - page 13, line 51 see figure 6 ----	1,12
A	EP 0 424 060 A (SONY CORP) 24 April 1991 see page 20, line 51 - page 23, line 53 see figures 15A-16 ----	1-22
A	CICALINI G ET AL: "DYNAMIC PSYCHOVISUAL BIT ALLOCATION FOR IMPROVED QUALITY BIT RATE IN MPEG-2 TRANSMISSION OVER ATM LINKS" ELECTRONICS LETTERS, vol. 32, no. 4, 15 February 1996, page 370/371 XP000558160 see page 370, right-hand column, line 31 - page 371, left-hand column, line 24 -----	1-22

# INTERNATIONAL SEARCH REPORT

information on patent family members

International Application No

PCT/SG 98/00034

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5686963 A	11-11-1997	US 5847761 A	08-12-1998
EP 0828393 A	11-03-1998	FR 2753330 A	13-03-1998
		CN 1176562 A	18-03-1998
		JP 10108187 A	24-04-1998
EP 0705040 A	03-04-1996	JP 8098179 A	12-04-1996
		US 5751358 A	12-05-1998
EP 0424060 A	24-04-1991	JP 3129987 A	03-06-1991
		AU 632178 B	17-12-1992
		AU 6463590 A	18-04-1991
		CA 2027526 A	15-04-1991
		EP 0800316 A	08-10-1997
		US 5136376 A	04-08-1992

Form PCT/ISA/210 (patent family annex) (July 1992)

**THIS PAGE BLANK (USPTO)**